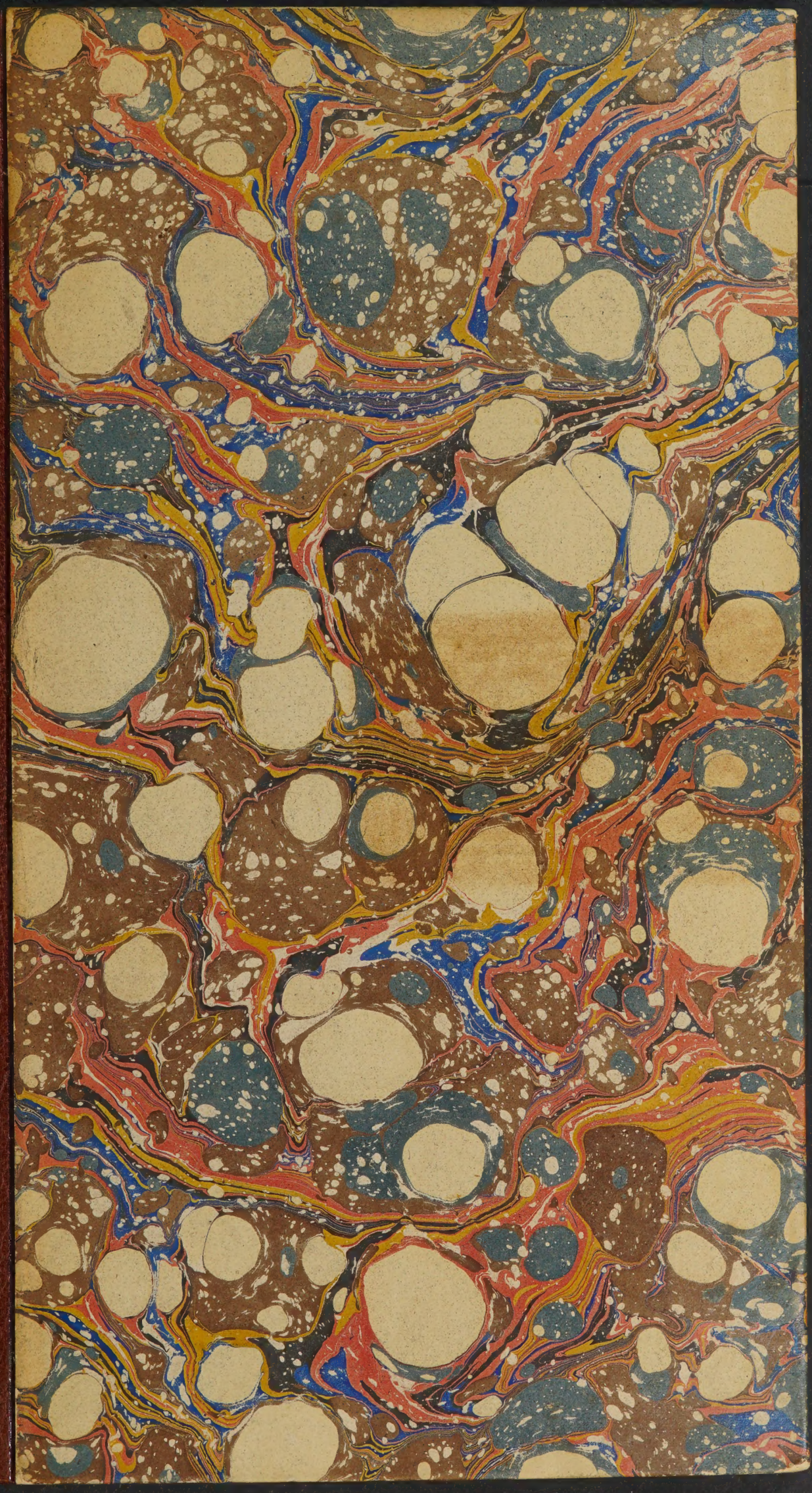

WINTHROP - TWO LECTURES - BOSTON 1769

Mr. *Winthrop*'s

LECTURES

On the USE of

THE TRANSIT OF VENUS.

TWO

LECTURES

ON THE

PARALLAX and DISTANCE of the SUN,

AS DEDUCIBLE FROM

The Tranſit of Venus.

Read in HOLDEN-Chapel at HARVARD-COLLEGE in CAMBRIDGE, *New-England*, in *March* 1769.

By JOHN WINTHROP, ESQ.

HOLLISIAN Profeſſor of the Mathematics and Philoſophy at *Cambridge*, and F. R. S.

Agite, mortales! et oculos in Spectaculum vertite, quod hucuſque ſpectaverunt perpauciſſimi; ſpectaturi iterum ſunt nulli.

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The Use of the Transit of Venus.

Lecture I.

A Transit of Venus under the Sun is the moſt uncommon, and the moſt important phænomenon, that the whole compaſs of aſtronomy affords us. So uncommon is it, that it can never happen above twice in any century; in others, but once; and in ſome centuries it cannot happen at all. And the importance of it is ſuch, as to ſupply us with a certain and complete ſolution of a very curious Problem, which is inacceſſible any other way. On both accounts it well deſerves a very particular attention.

The phænomenon itſelf is, the paſſage of the planet Venus acroſs the face of the Sun, from eaſt to weſt, in the form of a round, black ſpot. As we ſhall have the opportunity in a few months of viewing one of theſe phænomena, if the weather permit, I ſhall adapt my deſcription of them to the particular circumſtances of this Tranſit. This planet then, having approached the Sun on his eaſtern ſide, and arrived at his limb or edge, will,

will, by being opake, make a ſmall, black notch upon it; which, as ſoon as it is big enough to be viſible, is called the *firſt external contact*. The notch will immediately grow bigger, by the planet's advancing, and in about 9 minutes her centre will be got on the Sun's limb, and the appearance will be that of a little black ſemicircle, which will occupy about $3\frac{1}{2}$ degrees on the circumference of the Sun. When the planet is advanced above half, her circular figure will cauſe an appearance as of a luminous horn or cuſp on each ſide of it, with the points turned towards each other, and gradually approaching, and in 9 minutes more Venus will be wholly within the Sun's diſk, and the two luminous cuſps running together at their points, will form a narrow thread of light behind the planet. The Sun's limb now recovers its light, where it had been interrupted by the body of the planet. This is called the *immerſion*, or the *firſt internal contact*. In about 3 hours the planet will be in the middle of its courſe, and neareſt to the Sun's centre, from which it will be diſtant to the north about $\frac{1}{3}$ part of the Sun's diameter; its own diameter being $\frac{1}{32}$ part of the Sun's. Then approaching the weſtern ſide of the Sun, the thread of light between their limbs will grow narrower till it breaks, and Venus again touches the Sun's limb, forming, what is called, the beginning of *emerſion*, or the *laſt internal contact*. The light of the Sun's limb will now again be interrupted, and two luminous

nous cuſps formed, as before, which will recede from each other as the planet moves off from the Sun. In about 18 minutes, the *laſt external contact* will be formed, the impreſſion made by the planet upon the Sun's limb having become gradually leſs & leſs, till it is quite imperceptible.—Theſe ſeveral phaſes will be very conſpicuous with any teleſcope, and even with the moſt ordinary perſpective; but few eyes are ſharp enough to diſcern ſo ſmall an object as Venus diveſted of her radiance; her apparent diameter being leſs than a minute of a degree.

You ſee what are the appearances in a Tranſit of Venus.——The theory of it is eaſily underſtood.—Venus circulates round the Sun, the ſame way as the Earth does, that is, from weſt to eaſt, but in a ſmaller orbit, and in a ſhorter period. When Venus is in the ſame degree of the ecliptic with the Sun, ſhe is ſaid to be in *conjunction* with the Sun; and as her orbit is incloſed within the Earth's, it is plain, that a conjunction may happen two different ways; either by the planet's being beyond and *above* the Sun, and ſo in the remoteſt part of its orbit from us, which is called a *ſuperior conjunction*; or being *below* the Sun, and neareſt to us, and this is called an *inferior conjunction*.—The planet, having paſt a *ſuperior* conjunction, will appear to move quicker to the eaſt than the Sun does, whoſe apparent velocity is the ſame as the Earth's real velocity in its orbit; and thus will depart farther and

farther

farther from him, till ſhe has attained to the diſtance of 48 degrees; and this is her *greateſt elongation* from the Sun, her whole orbit being included within two right lines drawn from the Earth, at the diſtance of 48° eaſt and weſt of the Sun. She will now appear *ſtationary*, in reſpect of the Sun; and after this, while ſhe is deſcribing the neareſt part of her orbit contained between the two right lines juſt mentioned, will ſeem to move with a *retrograde* motion, or the contrary way to what ſhe did before; approaching the Sun from eaſt to weſt, and ſo will paſs through an *inferior* conjunction with him. Then running off to the diſtance of 48° weſt from the Sun, ſhe will again appear *ſtationary*; and after this, will be ſeen to reſume her *direct* or proper motion eaſtward, and will at length arrive at another *ſuperior* conjunction.—In the courſe of ſuch a revolution, ſhe puts on all the phaſes of the moon. Near the ſuperior conjunction ſhe appears round like the Full moon, but ſmall; after this, waning, like the moon after the Full; tho' her diameter grows larger, becauſe ſhe is coming nearer the earth. At her greateſt elongation ſhe reſembles the moon in the Quarters; and from thence to the inferior conjunction is cuſpidated or horned, like the moon from the laſt Quarter to the Change; that hemiſphere, which is enlightened by the Sun, being turned more and more from the Earth, till in the conjunction itſelf, it is wholly turned from us. Her diameter now appears largeſt.—

In

In all this time, being on the eaſtern ſide of the Sun, ſhe ſets after him; and for her extraordinary luſtre, is called, by way of eminence, the *Evening-Star*. She paſſes thro' the ſame ſeries of changes, but in an inverted order, from the inferior conjunction to the ſuperior, juſt as the moon does from the Change to the Full; and in this interval, being on the weſtern ſide of the Sun, and riſing before him, ſhe is called the *Morning-Star*.——Such are the phænomena of Venus.——It may be obſerved by the way, that thoſe of Mercury are altogether ſimilar; and that they demonſtrate beyond all doubt, that theſe planets perform their revolutions round the Sun, and not round the Earth.

FROM what has been ſaid 'tis obvious to collect, that it is only in the inferior conjunctions that Tranſits can happen.—If the orbit of Venus lay in the *ſame plane* as that of the Earth, or the ecliptic, there would be a Tranſit at every inferior conjunction; for in this caſe, the planet would paſs *directly between* the Sun and the Earth; and only her unilluminated ſide being turned towards us, ſhe muſt appear like a black ſpot upon the Sun's diſk. But the fact is otherwiſe. The orbit of Venus is *inclined* to the ecliptic in a certain angle, tho' but a ſmall one, and interſects it in two oppoſite points, called the *nodes*. At one of them, the planet croſſes the ecliptic from ſouth to north, which therefore is called the *aſcending* node; the

other, where she is moving from north to south, is called the *descending* node. 'Tis only at those inferior conjunctions which happen so near one of the nodes as to make Venus's *latitude*, or her distance from the ecliptic, less than the apparent semidiameter of the Sun, that we can have a Transit; at all others, Venus will pass clear of the Sun, either to the north or south; and that, at so much greater distance as she is farther from her nodes. And for this effect, the Sun must be within 2 degrees of a node; which arc he goes over in 2 days. In this age and the next, the nodes being situated near the middle of Gemini and Sagittarius, where the Sun is the 4th of June, and 7th of December, Transits can happen only at those times of the year; that is, between the 2d and 7th of June; and between the 5th and 10th of December. I shall confine myself at present to those which happen in June, when the planet is at its descending node, since it is with these we are more immediately concerned.—The conjunctions succede one another after an interval of about 584 days, or 1 year and 7 months; as is easily computed from the period of the Earth, which is nearly 365 days; and that of Venus, which is 224. When a Transit happens in the beginning of June, there cannot be another at the same node, till there is another inferior conjunction in the beginning of June, within the limits of the four days just specified. This will not be, till the interval of 584 days, repeated some number of

of times, will make nearly ſome number of years. To find when this may happen, reduce the ratio, 584 : 365, to its leaſt terms, and you will find it to be as 8 : 5; which ſhews that 5 of theſe intervals make 8 years: More accurately, they make 8 years wanting 2 days, 7 hours; which defect falls within the limits above aſſigned. This then is the ſhorteſt period in which one Tranſit can follow another.—The ſeveral conjunctions in this period ſucceed in the following order; June 6; January 11; Auguſt 14; March 25; October 25; and June 3. And this order is repeated in the next period; only the conjunctions happen 2 days ſooner. As the laſt of theſe Tranſits comes earlier in the year, and ſo the planet is not got ſo far to the eaſt as it was at the firſt, while the node remains nearly in the ſame place, it neceſſarily happens that the planet now deſcribes a different path from what it did before. By calculation we find that its path the laſt time is near 20 minutes more northerly than the firſt. And as the ſemidiameter of the Sun is near 16 minutes, if at the firſt of theſe conjunctions Venus paſt more than 4 minutes to the South of the Sun's centre, this laſt more northerly path will ſtill fall within the Sun's diſk on its northern half, and there will alſo be a Tranſit at the laſt of the conjunctions. This was the caſe in the Tranſit of June 1761, when Venus paſt near 10 minutes South of the Sun's centre; which is the reaſon why we ſhall have another in June

this preſent year, in which the planet will paſs 10 minutes North of the Sun's centre. But if in any Tranſit Venus paſs within 4 minutes South of the Sun's centre, or to the Northward of it, in the conjunction 8 years after ſhe will paſs quite to the North of the Sun's diſk, and there will be no Tranſit. Accordingly, in the conjunction which will happen June 1, 1777, Venus will paſs near 30^m north of the Sun's centre, and 14^m from his northern limb.—Thus you ſee that there cannot be another Tranſit after two conſecutive periods of 8 years. Let us inquire when there can be another.

FROM the foregoing account of the order in which the conjunctions ſucceed one another, it appears that the conjunction which happens neareſt after the 3d of June, in the courſe of the year, is on the 12th of Auguſt. There will therefore be no other Tranſit at the deſcending node, till the conjunction which falls on the 12th of Auguſt, by anticipating at the ſlow rate of 2 days, 7 hours, in 8 years, has got back to the 7th of June; which is 66 days. This cannot be done in leſs than 29 of theſe periods of 8 years, or 232 years, which make 235 years from the preceding Tranſit. Nor will it be done then, unleſs at the preceding Tranſit Venus paſt above 5^m north of the Sun's centre; otherwiſe it will take 8 years more to accompliſh it. Upon theſe grounds we find, that beſide the two in 1761 and 1769, no Tranſit has

has happened at this node, in the beginning of June, ſince the year 1526, nor will again till 2004.—The foregoing remark clears up what at firſt ſight appears ſo paradoxical, that there ſhould be two Tranſits at the ſame node in 8 years, and no more in ſo long a period.

ANOTHER may indeed happen before the year 2004, at the oppoſite node. For, agreable to the account of the order in which the conjunctions ſuccede one another, we ſhall find that, after a Tranſit on the 3d of June, the next conjunction will fall on the 9th of January; which is but a month after the time of year when Tranſits may happen at the aſcending node. The conjunctions going back ſomewhat quicker at this node, viz. 2 days and about 11 hours in 8 years, this ſpace of a month may be gone over in 13 of theſe periods, that is, in 104 years; or, reckoning from the preceding Tranſit, in 105 years and an half. Accordingly, the next Tranſit will be on the 9th of December in the year 1874; which will be follow'd by another in 8 years, and then there will be no more in December till the year 2117. Thus the 20th century will paſs without a Tranſit.

So extremely rare are theſe phænomena. And in fact, till that which was obſerved in 1761, there never had been but one ſeen ſince the creation. This was in December (N. St.) in the year

year 1639; and it was ſeen by two perſons only; Jeremiah Horrockes, a young Engliſh Aſtronomer, of an admirable genius, who was the only perſon that predicted it, and a friend of his, William Crabtree. And when this of next June is paſt, the preſent race of mortals may take their leave of theſe Tranſits; for there is not the leaſt probability, that any one who ſees this, will ever ſee another.

ON account of their rarity alone, they muſt afford an exquiſite entertainment to an aſtronomical taſte. But this is not all. There is another circumſtance which ſtrongly recommends them. They furniſh the only adequate mean of ſolving a moſt difficult Problem,—that of determining the true diſtance of the Sun from the Earth. This has always been a principal object of aſtronomical inquiry. Without this, we can never aſcertain the true dimenſions of the ſolar ſyſtem and the ſeveral orbs of which it is compoſed, nor aſſign the magnitudes and denſities of the Sun, the planets and comets; nor, of conſequence, attain a juſt idea of the grandeur of the works of GOD. Such as are unacquainted with this ſcience, are apt to look upon every thing that can be advanced with relation to this inquiry, as at beſt but mere conjecture. 'Tis however true, that methods have been propoſed for this purpoſe, which ſhew the great acuteneſs of the inventors, and are founded on mathematical demonſtration. The grand defect of them was,

that

that they required obſervations which could not be made with ſufficient exactneſs. And this is the reaſon why ſo capital a point has not as yet been duly ſettled.—This important uſe of the Tranſits of Venus was firſt pointed out by the ſagacious Dr. Halley in the year 1691, and largely explained by him in the Philoſophical Tranſactions in 1716, when that great Aſtronomer, deſpairing, by reaſon of his age, to reach ſo diſtant a period, moſt earneſtly left it in charge to the Aſtronomers who ſhould be on the ſtage, that with this view they would ſtrenuouſly and with all their might apply themſelves to make obſervations, in diſtant parts of the world, of the Tranſit in 1761; but eſpecially, that of the preſent year, on account of a peculiar advantage attending it, which we ſhall hereafter explain.—It will not be eaſy to give a diſtinct account of the ſeveral ſteps in the method of applying theſe phænomena to this purpoſe, without the uſe of diagrams, which are not ſutable to this place. I ſhall, notwithſtanding, endeavor to convey to you as clear an idea as I can, of the general method; and, in order to it, ſhall trace things from their firſt principles.

To find the diſtance of one object from another, the firſt way that preſents itſelf is, to repeat a known meaſure ſucceſſively till you have gone over the whole ſpace between the objects. But this ſuppoſes one of them to be acceſſible, from the other. If it is not, the method is impracticable,

ticable, and we muſt have recourſe to ſome other.—The properties of a plane triangle ſupply us with another. If two angles of a triangle are given, the third is given too; and the proportion of the ſides is alſo given; and therefore, if one of the ſides be given in magnitude, the others are given in magnitude alſo; as appears from Euclid's *Data*. In other words, If we can obſerve two angles of a triangle, and meaſure the length of one ſide, we can find the length of the other ſides.—To apply this to the caſe of meaſuring a diſtance on the land or ſea. Suppoſe we obſerv'd an object to bear due north from us, but having moved one mile to the eaſt, we find the object now bears N. W. Here, by drawing lines thro' our ſtations and the object, a triangle is formed, two of whoſe angles are known;—the angle at the firſt ſtation, which is 90°; and the angle at the object, which is 45°. One ſide is alſo known, viz. the diſtance between the ſtations. From theſe *Data*, it is eaſy to find the diſtance of the object, and that with the ſame degree of accuracy as the obſervations can be made. On the preſent ſuppoſitions, the diſtance of the object from the firſt ſtation is equal to the diſtance between the ſtations, that is, one mile. If the object were moved, provided its motion were known, its diſtance might be found on the ſame principles. This method is rendered univerſal by trigonometry, and may be extended to aſtronomical as well as geographical diſquiſitions. The

known

known distance between the stations is usually called the *base*; and the angle at the object, the *parallax*. This is a greek word, which signifies a *change*; and is used to denote that *change* in the apparent place of an object, which is occasioned by changing the observer's station.

CONCERNING this change or parallax, we must make a few *Remarks*, which will be of use to us in the sequel.

1. That the parallax is always made the contrary way to that which the observer has moved. As, if he move East, the object seems to have moved West; if he move North, that moves South; if he upward, that downward, &c.

2. The parallactic angle is so much the less, as the base is more obliquely situated in respect of the distance of the object.——It is also less,

3. As the base is less than that distance.

THE first of these Remarks is evident from the nature of parallax; the two last, from the properties of a triangle.

FROM the last Remark it appears, that this method is subject to limitations in practice;—owing to the limits which nature has prescribed to our senses. For when the base is the same, the parallax is less, as the distance of the object

is greater; and *vice verſa*. Therefore if the baſe be very ſmall in reſpect of the diſtance of the object, the parallactic angle may be ſo ſmall, that it may be extremely difficult to obſerve it. Thus, if we ſhould attempt to find the diſtance of an object, which was 20 miles or more, by changing our ſtation only 5 feet, the parallactic angle would not be quite 10 ſeconds; which is ſo ſmall that it can ſcarcely be obſerved, even with very nice inſtruments. In ſuch ſmall angles, the convergence of the lines is ſo ſlow, that a ſmall error in obſerving the angle will make a great difference in the diſtance of the point of interſection.

IT is plain enough, that our hopes of finding the diſtances of the heavenly bodies, with any certainty, muſt be built on obſervations of their parallaxes. If the diameter of the Earth bear any ſenſible proportion to the diſtance of an heavenly body, that body muſt be ſubject to a parallax, of ſome quantity or other; that is, it muſt appear in different points of the ſtarry heaven, when view'd from different parts of the Earth. For this reaſon, Aſtronomers reduce all obſervations, wherever made, to the *centre* of the Earth, which they conſider as the only *true* point of view. The ſemidiameter of the Earth, then, is the *baſe* which ſubtends the parallactic angle. Indeed, if we compare obſervations made in oppoſite parts of this globe, then the whole diameter of it will become the baſe, and will

will ſubtend the ſum of the two parallaxes. And this is the greateſt baſe we can poſſibly get, for inveſtigating theſe parallaxes.

THE immediate effect of parallax is, to make a ſtar appear *below* its *true* place, according to our firſt Remark; becauſe the Obſerver is *above* the centre of the Earth. But while parallax alters the poſition of a ſtar in reſpect to the horizon, it muſt alter it, to the other circles of the ſphere too, as the equator, ecliptic, &c. and thus it alters the times of the ſtar's arrival at thoſe ſeveral circles. When a ſtar is in the horizon, its parallax is greateſt; that ſemidiameter of the Earth, at the end of which the obſerver is placed, being then directly oppoſite to the parallactic angle, and perpendicular to the diſtance of the ſtar. So that the horizontal parallax of any ſtar is equal to the angle under which the ſemidiameter of the Earth would appear, if ſeen from that ſtar. As the ſtar riſes, this ſemidiameter becoming more oblique, the parallax diminiſhes, according to the ſecond *Remark*. And if the ſtar comes to the zenith, the parallax vaniſhes; the ſtar then appearing in the ſame place as if it were viewed from the centre of the Earth. For the contrary reaſon, when a ſtar is deſcending towards the horizon, its parallax muſt increaſe.

HENCE it appears, that if one perſon could obſerve the place of the Sun or a planet, in the ſtarry heaven, when in his zenith, and another

at the ſame time, at the diſtance of 90°, obſerve it in his horizon, the difference of the two obſerv'd places would be the horizontal parallax ſought. But this method, eſpecially with regard to the Sun, tho' the moſt obvious of all, is attended with inſuperable difficulties. And indeed, ſo are all other methods of attempting the Sun's parallax, immediately. But, happily, we are under no neceſſity of confining ourſelves to this. As we know the proportion of the parallaxes of the ſeveral planets, if we can diſcover the real quantity of any one of them, we diſcover all the reſt. We are therefore at liberty to chooſe that which we find moſt convenient; and, according to our 3d *Remark*, that planet will be moſt convenient, which comes neareſt to the Earth. This limits the inquiry to Mars, of the ſuperior planets; and Venus, of the inferior. Mars, in his oppoſition to the Sun, at his mean diſtance, is but little more than half ſo far from us as the Sun is, their diſtances being then nearly as 11 to 21; and therefore his parallax then is almoſt twice as great as the Sun's. But if he be in his perihelion at the ſame time,† he comes conſiderably nearer, his diſtance being to the Sun's as about 8 to 21; and ſo his parallax is proportionally greater.—Venus in her inferior conjunction is but little more than one quarter ſo far from us as the Sun is, and therefore her parallax almoſt four times as great as his. This therefore is the moſt advantageous circumſtance. But

† As he was 13th Aug. 1766; but will not be again in many years.

But a Tranſit of Venus is the moſt favorable conjuncture of all, becauſe the limbs of the Sun afford the beſt terms with which to compare the planet; and inſtead of trying to obſerve the parallactic angles, which are extremely ſmall, it is much better to obſerve the differences of time, occaſion'd by them, which are much more ſenſible. For Venus on the Sun moves 1 ſecond of a degree in 15 ſeconds of time. Now a ſecond of time is very perceptible; but a ſecond of a degree can ſcarcely be diſcerned; much leſs can $\frac{1}{15}$ part of a ſecond be ſo. The beſt obſervations will be, when the planet is in contact with the Sun's limbs, at its immerſion and emerſion; the moments of which may be determined with great accuracy, if the air be clear, by ſuch as are furniſhed with good aſtronomical inſtruments, and are expert in the uſe of them.

IF it be enquired, whether the Tranſits at one node have any advantage above thoſe at the other, the anſwer is, that, *cæteris paribus*, thoſe in December, at the aſcending node, are preferable. The reaſon is, Venus is then about $\frac{1}{72}$ part nearer to us than in June. But this advantage, tho' real, may be much overbalanced by other circumſtances, which we ſhall mention when we come to explain the manner in which the parallax may be deduced from ſuch obſervations. But this muſt be the ſubject of another diſcourſe.

Read, 1ſt March 1769.

LECTURE

LECTURE II.

IN the concluſion of the laſt diſcourſe we remarked that a Tranſit of Venus is the moſt favorable conjuncture that can offer, for inveſtigating the parallax of the Sun and planets ;—a fundamental element in aſtronomy, which neceſſarily enters into the theory of thoſe bodies ; and yet is extremely difficult to be ſettled with exactneſs by its being ſo very ſmall, as almoſt to eſcape the moſt critical obſervation. It was farther remarked, that the beſt method for this inveſtigation is, to obſerve the differences of time occaſioned by parallax, at the ingreſs and egreſs of the planet. Our next buſineſs then is to inquire, in what manner the times of theſe phaſes will be affected by parallax in different parts of the Earth.—They will be affected both by the difference of Longitude, and the difference of Latitude. There is accordingly, a *parallax in Longitude*, and a *parallax in Latitude*†. The former alters the time, as the Obſerver is

† In Geography, Longitude and Latitude are referred to the Equator; in Aſtronomy, to the Ecliptic. This diſtinction was here paſt over, to avoid embaraſſing the ſubject ; and there was the leſs need to inſiſt upon it, becauſe in the preſent caſe, the former neceſſarily involves the latter.

is farther East or West; the latter, as he is farther North or South. Their effects, tho' blended together, must be examined separately.—We begin with the *parallax in Longitude.*

LET us suppose an Observer on such a place of the Earth, as that he can see the first external contact of Venus, when the Sun is in his Zenith, and therefore at Noon: He sees this contact without parallax, that is, at the same instant of time as he would, if he could see it from the centre of the Earth.—Suppose another Observer *West* from the former, and under a meridian 6 hours distant. To him, the Transit will begin at Sunrise, in the lower half of the Sun. Both the Sun and Venus being depress'd by parallax, and Venus more than the Sun, because nearer; at the time when the contact is formed to the first Observer, it will not yet be formed to the second; but Venus's western limb will be as far distant below the Sun's eastern limb, as her parallax excedes the Sun's; and the contact cannot happen, till the planet has gone over this distance, which is called *her parallax from the Sun.* The contact therefore will not happen at 6 o'clock, but some time after. And if the two Observers should compare their observations; instead of finding the difference of the observed times of contact to be the same as the difference of their meridians, viz. 6 hours, as they would, if there were no parallax, they will find it to be less than 6 hours.—Suppose a third Observer

6 hours

6 hours *East* from the first. He will see the Transit begin at Sunset. As the Sun's eastern limb, on which Venus enters, is now the uppermost, 'tis evident that Venus, depress'd by parallax, will be brought into contact with this limb, sooner than if there were no parallax. To this Observer, therefore, the contact will happen before 6 o'clock; and upon a comparison of this observation with the first, the difference of the times will here also be found less than 6 hours, which is the proper difference of meridians; and as much less, as it was in the foregoing case.—But if the Western and Eastern observations should be compared together, the difference of their times from 12 hours would be double of the preceding difference from 6 hours, when each of them was compared with the Zenith observation.—The same thing is to be said of the first internal contact; as also, of the two contacts at the egress. Each of these phases will happen *later* to those who see them in the *East*, and *sooner* to those who see them in the *West*, than to those who see them in the zenith, or indeed, near the meridian.—You see what a difference is made in the beginning and end, by the parallax in Longitude.

FROM hence it follows, in the *second* place, that the *whole duration* of the Transit will be alter'd by this parallax in Longitude. If our Western Observer, who sees the beginning in the East, and therefore later, could travel so far Eastward as to see the end in the West, and

therefore ſooner, it is plain that the duration of the Tranſit would be *ſhortened* to him. The rotation of the Earth produces the ſame effect: It tranſports an Obſerver from Weſt to Eaſt, during the continuance of the Tranſit; ſo that he, who ſaw the beginning in the Eaſt, may ſee the end in the Weſt. On this account, the Tranſit will be ſhorter to thoſe parts of this globe, which have the beginning of it in the Morning, and the end in the Afternoon, than it would be as ſeen from the centre of the Earth. And it is not neceſſary that the obſervation ſhould be made in a place where the middle of the Tranſit happens juſt at noon: It is ſufficient, if it be within an hour or two, before or after it. The contraction of the duration will be much the ſame, if the Latitude be the ſame. The duration will be moſt contracted, on this account, from the northern tropic, near which the Sun will then be, to the equator. From theſe limits, either to the north or ſouth, it will ſtill be contracted, tho' not ſo much; becauſe the degrees of the parallels of Latitude, which meaſure the baſe of the parallactic triangle, or the ſpace thro' which the Obſerver is carried eaſtward, grow leſs as you advance toward either of the poles.

THE reverſe will take place with reſpect to ſuch parts of the Earth as have the middle of the Tranſit not far from midnight, and therefore ſee the beginning in the Weſt, and the end in the Eaſt; which will be the caſe with places ſo far North

as

as to have their night ſhorter than the duration of the Tranſit. For, the beginning in the Weſt being accelerated by parallax, and the end in the Eaſt, retarded, it is manifeſt that the whole duration muſt be *protracted*, and be longer than it would be, as ſeen from the centre of the Earth.—Or the thing may be conſidered in this light. Where the middle is near noon, the Obſerver is carried, by the rotation of the Earth, with a motion contrary to that of Venus; the former being from Weſt to Eaſt, the latter from Eaſt to Weſt. This accelerates Venus's apparent motion on the Sun. But where the middle is near midnight, the Obſerver, being on the oppoſite ſide of the Earth, is carried in a direction contrary to the former, and therefore the ſame way as Venus; and this retards her apparent motion on the Sun. Theſe different effects of contrary motions have been well illuſtrated by an ingenious writer, Mr. Ferguſon (Aſtron. p. 39.) "If two "birds, ſays he, fly along ſide of a ſhip under ſail, "in contrary directions to each other, the bird "which flies contrary to the motion of the ſhip "will paſs by its whole ſide ſooner than the "other bird will, which flies the ſame way as "the ſhip ſails." The protraction of duration in theſe northern parts on account of the parallax in Longitude, will be diminiſhed as you advance toward the north pole, becauſe the parallels of Latitude diminiſh. In the pole itſelf, the protraction on this account would be nothing; and it will be greateſt, in that Lati-

tude where the night is but little ſhorter than the Tranſit, and where conſequently, the beginning might be ſeen a little before Sunſet, and the end a little after Sunriſe; as it may be in ſome places in the Latitude of 60° N. If theſe lengthened durations, obſerved where the middle is not far from midnight, be compared with thoſe ſhorten'd ones, where the middle is not far from noon, the differences will be much greater than if either of them were compared with the true duration as ſeen from the Earth's centre.

THE foregoing differences may be altered, and made greater or leſs, by the *parallax in Latitude*, which is the *third* particular we have to ſpeak of. A perſon who ſees Venus in his Zenith, ſees her without parallax, and therefore in the ſame place on the Sun as if the view were taken from the centre of the Earth. One to the Southward of the former, will ſee Venus more Northerly on the Sun; and one to the Northward, more Southerly; according to the firſt *Remark* we made concerning parallax. For this reaſon, if a plane be conceived to paſs thro' the centre of the Earth and that little arc of Venus's orbit which falls within the Sun's diſk, all the inhabitants of the Earth, when to the Southward of that plane, ſee Venus with a Northern parallax of Latitude; that is, they ſee her more Northerly on the Sun, than ſhe would appear, from the centre of the Earth; and all to the Northward of it ſee her with a Southern

Southern parallax; but all in the plane it ſelf, ſee her without any parallax of Latitude. Such a plane, about the place which is in the middle of the Earth's enlighten'd diſk, where the Sun is in the Zenith, will croſs the ſurface of the Earth juſt within the tropic of Cancer; on the Weſtern ſide of that place, it will paſs more Southerly; and on the Eaſtern, in general, more Northerly;——by reaſon of the inclination of Venus's orbit to the equator.—The effect of this parallax is, to make the planet appear to paſs at *different diſtances* from the Sun's centre, and conſequently to deſcribe chords of *different lengths* on his diſk; and thus it will vary the duration of the Tranſit. The variations on this account will be ſo much greater, *cæteri paribus*, as the path of Venus on the Sun is farther from his centre; becauſe the farther the chords of a circle are from the centre, ſo much quicker they alter in length.—The change of duration by this parallax will not be made the ſame way as by the parallax in Longitude, if the Declination of the Sun and the Latitude of Venus are of different denominations, one North, the other South; but when they are of the ſame denomination, the change will be made the ſame way; and the difference of duration in diſtant parts of the Earth will be more conſiderable in the latter caſe than in the former. In June the Declination of the Sun is *North*. If Venus paſs *South* of the Sun's centre, the inhabitants of the Southern part of our globe, who would ſee her

her about noon with a Northern parallax of Latitude, would ſee her paſſing *nearer* to the Sun's centre, deſcribing a longer chord, and conſequently continuing *longer* within the Sun. But to the inhabitants of this part of the globe, the duration would be *ſhortened* by the parallax in Longitude; as we ſhew'd under the *ſecond* article.—On the other hand, where the middle was near midnight, and where the duration would be *protracted* by the parallax in Longitude, the inhabitants being in a high North Latitude, would ſee Venus with a conſiderable Southern parallax of Latitude, which would carry her farther from the Sun's centre, and by making her deſcribe a ſhorter chord on his diſk, would *ſhorten* the duration of her Tranſit. Thus, in the ſuppoſition, that Venus paſt *South* of the Sun's centre, the parallaxes in Longitude and Latitude would counteract one another; one would ſhorten the duration in the ſame parts of the Earth where the other lengthens it; which would diminiſh the difference between them. This was the caſe in 1761.—But in the Tranſit of the preſent year, the contrary will happen. Venus will now paſs *North* of the Sun's centre; and therefore moſt of the inhabitants to the Southward of the tropic of Cancer, who have the middle of the Tranſit within an hour or two of noon, and ſo have the duration of it *contracted* by the parallax in Longitude, will ſee the planet, with a Northern parallax in Latitude, in a more Northerly path,

that

that is, passing *farther* from the Sun's centre, and consequently describing a shorter chord, and having a *shorter* duration within the Sun. And tho' the parallax of Longitude is not quite so great in the high Southern Latitudes, as between the equator and tropic of Cancer, yet the parallax of Latitude is so much greater as to more than make amends for it.—On the other hand, where the middle is near midnight, and the duration *protracted* by the parallax of Longitude, there the inhabitants, on account of their high North Latitude, must see Venus with a considerable Southern parallax of Latitude. Her path will therefore to them appear not so far to the North, but nearer the Sun's centre, and consequently *longer*. In the case therefore of the present Transit, the parallaxes of Longitude and Latitude conspire to produce the same effects; both of them *shorten* the duration in the *Southern* parts of the Earth, and both *lengthen* it in the Northern. This is the peculiar advantage, hinted in the preceding discourse, which the next Transit will have above the last, for ascertaining the exact quantity of the Sun's parallax. The general method of doing which you may now easily understand.

FROM what has been said, it appears that there are two ways in which the observations of this celebrated phænomenon are applicable to the present research. Observations of only the beginning or end, made in different places, may

may be compared; or, obſervations of the whole duration may be compared. It will be eaſy to obtain many more obſervations of the former kind than of the latter, becauſe a great number of places on theEarth are ſituated, ſo as to ſee one or other of theſe phaſes, which are not able to ſee them both. You perceive that parallax differs in its operation in various parts of the Earth, both in kind and in degree: In ſome, it accelerates; in others, it retards; and that, more or leſs, according to the different ſituation of the places. And in each place, its effect will be greater or leſs, in the ſame proportion as the Sun's total or horizontal parallax is greater or leſs.

IN the former way of proceding, the obſerved times of the beginning or end muſt be comparedwith the difference of the meridians where the obſervations are made; andany exceſs or defect found between them is owing to the operation of parallax; and from the quantity of this exceſs or defect, the quantity of the Sun's parallax may be calculated. The method of calculation is indirect, or *tentative*. The Sun's parallax is aſſumed to be of a certain quantity, namely, that which from former obſervations we know to be, either the truth, or at leſt, very near it; and from hence, the effects of parallax both in Longitude and Latitude muſt be computed for each place of obſervation; the particular proceſs of doing which,

which, may more properly be explained elſewhere. The total effect of both parallaxes being thus found by computation, ſo as to get the difference of times when the phaſes of the Tranſit ſhould happen in each place; if the obſerved difference comes out the ſame as the calculated, it will be certain the Sun's parallax was rightly aſſumed; but if the obſerved difference turns out greater or leſs than the calculated, it will follow that the true quantity of the Sun's parallax is greater or leſs than that which was aſſumed. To explain this by an example. The difference of meridians between the Royal Obſervatory at Greenwich and this, is $4^h\ 44'$. By calculation we find, that aſſuming the Sun's parallax to be $8''$, 55, as it was found to be nearly by the laſt Tranſit, the external and internal contacts, at the beginning of the next, will be accelerated by parallax 7 minutes of time at Greenwich; happening there but a little before Sunſet, when parallax has its greateſt effect. With us, where it will begin about half an hour after II, when the Sun is about 54° high in the weſtern hemiſphere, the contacts will be accelerated by parallax but 4 minutes. Therefore, if obſervations be made in both places and compared, the times ſhould be found to differ but $4^h\ 41'$; which falls ſhort of the difference of meridians, by $3'$. This is on the ſuppoſition that the Sun's parallax is $8''$, 55; a parallax of this quantity being juſt ſufficient to produce here this defect of 3 minutes. A greater parallax

would produce a greater defect; and a leſs parallax, a leſs defect. If therefore the obſerved difference of the times ſhould be found greater or leſs than $4^h\ 41'$, and conſequently its defect from the difference of meridians greater or leſs than 3 minutes, the inference muſt be, that the Sun's true parallax is greater or leſs than $8'',55$, in the ſame proportion. Whereas ſhould this defect appear to be exactly 3 minutes, we might be aſſured that the Sun's parallax is exactly $8'',55$. Thus ſhall we obtain the true value of the Sun's parallax.—In this example, which is deſigned purely for illuſtration, I have taken no notice of the *ſeconds* of time. But it is of the higheſt importance, that in making the obſervations they ſhould be attended to with the moſt critical accuracy. And herein lies one great advantage of theſe Tranſits above every other phænomenon that can be uſed for finding the parallaxes of the planets, namely, that the obſervations can be made with much greater exactneſs. For the times of Venus's contacts with the Sun's limb may be determined, by experienced Obſervers and in favorable circumſtances, within a very few ſeconds; as was intimated before.

As the two places in this inſtance differ not much in Latitude, which is North in both; and the obſervations in both muſt be made in the Afternoon, and ſo the operation of parallax is alike in both, viz. to accelerate the beginning, there is a difference of only 3 minutes of time, occaſioned

occaſioned by the parallax. If the Greenwich obſervation ſhould be compared with one made in South latitude, and in a place ſo far Weſt as to have the beginning happen in the Morning, where the effect of parallax will be contrary, and retard the beginning, the difference would be more conſiderable. But to take the utmoſt advantage of theſe obſervations, we ought to make the difference of time as great as poſſible; and therefore, the afternoon obſervation ſhould be made in ſome place where the beginning happens not long before *Sunſet*, but yet long enough to have the Sun of a ſufficient height; and where the planet will be ſeen to enter on the *higheſt* point of the Sun; for then parallax will have its full effect in *accelerating* the contacts, by depreſſing the planet directly downward upon the Sun's limb. This place I find to be near the latitude of 50° N, and about a quarter of an hour Eaſt of Greenwich. But Greenwich itſelf, or indeed any part of Great-Britain or Ireland, will ſerve very conveniently for this obſervation. The correſponding obſervation, to be compared with this, ſhould be made, if poſſible, in a place where the beginning happens not long after *Sunriſe*, and the planet enters on the *loweſt* point of the Sun; for then parallax has its full effect in *retarding* the contacts, by depreſſing the planet directly downward from the Sun's limb. The place where this will happen, is nearly oppoſite or antipodes to the former, in the Southern part of the great South Sea.

Sea, not far from which is marked on our globes a tract of land but little known, called New Zealand. If an obſervation could be made there, it would be found to differ from the Greenwich obſervation about 14 minutes of time; the difference being double of what it would be, if each were compared with an obſervation in the Zenith, which might be made on the weſtern coaſt of Mexico, juſt within the tropic.—All this is as applicable to the egreſs of the planet, as to its ingreſs; Only the ſtations muſt be different. The egreſs will happen *ſooneſt*, in the loweſt point of the ſetting Sun, in the South ſea, near the tropic of Capricorn, and meridian of California; and *lateſt*, in the higheſt point of the riſing Sun, in Arabia; the difference being about 14 minutes, as before.—To diſmiſs this head, it is plain, that in this way of inveſtigating the Sun's parallax, it is abſolutely neceſſary to have the Longitudes of the places of obſervation determined with the moſt rigorous exactneſs; for the ſucceſs of the whole depends on comparing the obſerved differences of time with the known difference of meridians.

THE other way of deducing the Sun's parallax is, by comparing obſervations of the whole duration of the Tranſit, made in diſtant places. From the preceding diſcourſe it appears that to the inhabitants of the Southern parts of this globe, who have the middle of the Tranſit about Noon,

Noon, as will be the caſe in the South Sea, the duration of it will be *ſhortened* by both parallaxes; and that to the inhabitants of the Northern parts, who have the middle of the Tranſit in the night, or when the Sun is near the North part of the meridian, below the pole, the duration will be *lengthened* by both. This will be the caſe in Lapland. But here again, ſuch ſtations ſhould be choſen as will make the greateſt difference in the duration. The beſt places for the latter obſervations will be near the polar circle, rather within it, and about 20° or 30° Eaſt from London; between the bottom of the gulph of Bothnia and the North Cape. There, the duration between the internal contacts will be about 5^h 54′; and this is the longeſt that will be any where ſeen. And the beſt for the former will be in the ſouthern part of the South ſea, not far from the oppoſite meridian. It is not indeed known, whether there be any land ſituated in that part of the globe. Nor is there any known place, that can ſee the end of the Tranſit, nearer to it than Mexico, in the Latitude of 20° N. and in that place there will be hardly any parallax of Latitude, Mexico being very near the plane paſſing thro' the centres of the Earth and Venus. But by the parallax of Longitude alone, the duration will be made about 18 minutes ſhorter there than in Lapland. If an obſervation could be procured in the Latitude of 55° S. where the parallax of Latitude as well as that of Longitude will have a great effect, the duration

ration would not be above 5^h 30′; that is, no leſs than 24 minutes ſhorter than in Lapland; which is ſo conſiderable a difference, that the Sun's parallax muſt be aſcertained by it to vaſtly greater exactneſs than can be done any other way. And in this way, there is no need of being ſcrupulouſly nice as to the Longitudes of the places of obſervation: A conſiderable error in them, even of ſeveral degrees, will only make the difference of a few ſeconds in the duration.

THERE is yet a third way of deducing the parallax, and that is, from obſervations of the leaſt diſtance of Venus from the Sun's centre, at the middle of her Tranſit. But this diſtance being uſeful, chiefly as it ſerves to determine the total duration, I need not enlarge upon it.—I may add, however, that if an obſervation could be made of this leaſt diſtance, in the Latitude of 63° N. and Longitude of 60° E. from London, where the middle will happen at Sunriſe; and another in the oppoſite place of the Earth, where it will happen at Sunſet, the compariſon of theſe two diſtances would give the double of Venus's parallax from the Sun, immediately and without calculation. The former place is in Siberia, the latter in the unknown ſouthern parts of our globe, and probably inacceſſible. An obſervation at the former might, notwithſtanding, be compared, to advantage, with a ſimilar

ſimilar one made in any high ſouthern Latitude. —But enough of this.†

IN conſequence of Dr. Halley's recommendation, great endeavors were uſed to have the Tranſit in 1761 duly obſerved. The approach of this intereſting and long-expected phænomenon excited the curioſity of every one who had the leaſt reliſh for Science; & engaged Aſtronomers, wherever ſituated, to employ all their ſkill and care in making ſo critical and delicate an obſervation. The moſt learned Societies & the firſt Monarchs in Europe exerted their influence and power with emulation on this ſingular occaſion. It is beſide the preſent purpoſe to give a detail of the ſeveral obſervations that were made: They may all be ſeen in the Philoſophical Tranſactions. I ſhall content my ſelf with mentioning thoſe which were made at the greateſt diſtances from the Royal Obſervatory at Greenwich.—The moſt Northern place the Tranſit was obſerv'd at, was in EUROPE, namely, Tornea in Lapland; almoſt under the polar circle.—In ASIA, it was obſerved at Tobolſk, the capital of Siberia, by a French Aſtronomer, who performed a journey thither of 4000 miles from Paris, at the inſtance of the Imperial Academy of Sciences at Peterſburg, and under

† My ſubject did not lead me to ſpeak of the uſe of Tranſits in determining Longitudes; tho' thoſe of Venus, and of Mercury too, of which laſt there are 13 or 14 in 100 years, are certainly one of the beſt means in the world for this purpoſe, when once the parallax of the Sun is exactly determined.

under the Auſpices of the Czarina. This place was fartheſt *Eaſt*. It was obſerved beſides at Madraſs, which was fartheſt *South-eaſt*, under the direction of the Eaſt-India Company of London. The French King alſo commiſſioned two Members of his Royal Academy of Sciences, to make the obſervation in the Eaſt-Indies.—In AFRICA, it was obſerved only at the Cape of Good Hope: It would have been ſo at St. Helena too, had not clouds prevented; by Aſtronomers ſent to thoſe places by the Royal Society, at the expence of his late Majeſty K. GEORGE II. The Cape of Good Hope was the fartheſt *South*.—In AMERICA, it was obſerved only at St. John's Newfoundland; and that at the expence of the Province of the Maſſachuſetts-Bay. And this place was the fartheſt *Weſt*.

THESE obſervations and all the others were collated, and the proper computations and concluſions made from them, with incredible induſtry and patience, by the late ingenious Mr. Short of London, F. R. S. tho' he was able to make but little uſe of the *ſecond* method, viz. by the total duration; the greateſt difference obſerved, which was that between Tobolſk and Madraſs, amounting only to 2 minutes, 50 ſeconds. In a Paper publiſhed in Phil. Tranſact. for the year 1763, he has given the reſult of the whole; which is, that the parallax of the Sun, on the day of the laſt Tranſit, was 8″, 56.

But

But in a Letter he was pleaſed to write me afterward, dated London 23 July, 1766, he has the following words. "I have, ſince the publication of that Paper on the Sun's parallax which you were pleaſed to approve of, collected the obſervations of the late Tranſit made at many more places than I then had; ſo that by a compariſon of 43 places with the obſervation at the Cape [of Good Hope] the mean reſult of the Sun's parallax, by the internal contacts, is 8″, 545; and by the external contacts, 8″, 551."

ACCORDING to this laſt determination of Mr. Short, I find the Sun's parallax at his mean diſtance from the Earth to be 8″, 68; and conſequently this mean diſtance to be 23,763 ſemidiameters of the Earth. And as, by the lateſt meaſures, a mean ſemidiameter of the Earth is 3,957 miles, the mean diſtance of the Earth from the Sun is 94,030,000 miles nearly. And in this we muſt acquieſce till the next Tranſit; at which time, if the Aſtronomers diſperſed in the ſeveral parts of this globe, prove ſucceſsful in their obſervations, we ſhall be able to determine the Sun's diſtance to a greater degree of preciſion, and from thence aſcertain the juſt dimenſions of the whole ſyſtem. For,

CARE has been taken in due ſeaſon to ſtation Aſtronomers in ſome of the moſt ſuitable places of the Earth. We are told that the Czarina

has ſent out eight companies to the moſt northern parts of her empire†, where the whole duration will be viſible and of the greateſt length; and that the French King has ſent Obſervers to other remote parts; tho' we have not yet learned the particular places of their deſtination. The Royal Society with the aid of the Government have ſent ſeveral into the South ſea, who, it is to be hoped, will be able to obſerve the duration where it will be ſhorteſt. It was alſo propoſed to ſend ſome into Hudſon's Bay; but whether they actually went, I am not able to ſay*.—The beginning may be ſeen in Great-Britain and Ireland, and all over America; and the end, in the Eaſt-Indies; but the beginning happening before Sunriſe in the Eaſt Indies, and the end after Sunſet with us, will prevent obſervations of the whole duration. All Africa and the biggeſt part of Europe will be entirely deprived of this curious ſpectacle. IT

† It is a fortunate circumſtance for thoſe Northern Miſſionaries, who are gone to unknown parts of the Ruſſian empire, that there is to be an eclipſe of the Sun on the morning of the Tranſit. This, if they have weather to obſerve it, will enable them at once to ſettle their Longitudes; proper phænomena for which, ſeldom occur in thoſe regions of perpetual day.—Extremely unfortunate it would have been, had this eclipſe happened but 6 hours ſooner: It would then have intercepted their view of the Tranſit.

* The equal-altitude and Tranſit-Inſtruments for theſe ſeveral aſtronomical Miſſions, as well thoſe from France and Ruſſia as from Britain, were all made by the accurate hand of Mr. Bird of London, who alſo made the Inſtrument of that kind which lately arrived here for the uſe of this College.

IT were greatly to be wiſhed that we could obtain an obſervation of the whole duration, in this quarter of the world. If made with exactneſs, it would be a valuable addition to the ſtock of this ſort of obſervations, which, after the utmoſt exertions, it is to be feared will be but very ſmall; as there are but few places, at leaſt that are acceſſible, in which both the beginning and end will be viſible.* The neareſt place to us at which an obſervation of this ſort could be made, is Lake Superior, where the end will happen a little before Sunſet. An expedition thither, I am ſenſible, would be attended with difficulties; but in ſuch an expedition, what are the difficulties, which love of Science in Perſons poſſeſſed of wealth and power, and reſolution in the undertakers, cannot ſurmount? ‡

I

* The only places which can ſee the whole of the Tranſit, are, the South ſea, thoſe parts of America which lie N. W. of a circle drawn thro' the northweſt ſide of the gulph of Mexico, Lake Huron, the ſouth end of James's Bay, the eaſt end of Hudſon's ſtraits and the ſouth part of Greenland: Alſo, all within 67° of the N. pole, Kamſhatka, Japon, the Ladrone Iſlands and New Zeland.

‡ Extract of a Letter to the Author from a Gentleman of the firſt diſtinction in the literary world, dated London, July 2, 1768. "The Reverend Mr. Maſkelyne [Aſtronomer-Royal at Greenwich] wiſhes "much that ſome of the Governments in North-"America would ſend an Aſtronomer to Lake Superior "to obſerve this Tranſit. I know no one of them more "likely to have a Spirit for ſuch an undertaking, or a "Perſon and Inſtruments ſuitable, than the Maſſachu-"ſetts.—If your health and ſtrength were ſufficient for "ſuch an Expedition, I ſhould be glad to hear you had "undertaken

I CONCLUDE with the emphatical words of the Rev. Mr. Hornſby, the preſent Savilian Profeſſor of Aſtronomy at Oxford, who, in a diſſertation on this ſubject addreſs'd to the Royal Society about three years ago, (Phil. Tranſ. 1765. p. 326) having ſhewn the neceſſity of ſending Obſervers into the South ſeas, which has accordingly been done, adds, "An opportu-
"nity of obſerving another Tranſit of Venus
"will not again offer itſelf till the year 1874.
"It behoves us therefore to profit as much as
"poſſible by the favorable ſituation of Venus
"in 1769,* when, we may be aſſured, the
"ſeveral Powers of Europe will again contend
"which of them ſhall be moſt inſtrumental in
"contributing

"undertaken it. Poſſibly you may have an *Elève* that
"is capable. The fitting you out to obſerve the former
"Tranſit, was a public Act for the benefit of Science,
"that did your Province great honor."

Had it been poſſible, I would have undertaken this affair with the utmoſt alacrity; but my ſtate of health abſolutely forbidding it, I was obliged, to my great mortification, to decline all thoughts of it; and could only endeavor to procure an obſervation by ſome other means. Accordingly, I made a propoſal for that purpoſe, and perſued it, as far as I could, and had the pleaſure to find that it met with the approbation and countenance of many Gentlemen of Rank and Fortune. But ſince the above Diſcourſe was read, I find that in literary expeditions as well as others, there may be ſuch things as inſurmountable difficulties.—A perfect obſervation was not likely to be obtained: An imperfect one would be of little ſervice.—The propoſal failed of being carried into execution.

* This ſituation, from the principles laid down in p. 29. find to be more favorable for the inveſtigation of paral lax than any from the year 1526 till 2125.—Six hun dred years!

" contributing to the Solution of this grand " Problem, [finding the parallax.] Poſterity muſt " reflect with infinite regret upon their negli- " gence or remiſneſs; becauſe the loſs cannot " be repaired by the united efforts of induſtry, " genius, or power."

Read 15th March 1769.

THE END.

Advertiſement.

AS it is very probable, that a great number of perſons may have the curioſity to behold ſo uncommon a ſight as that of Venus in the Sun, I think it neceſſary to give a public caution, that no Body ſhould venture to look on the Sun, without defending his eyes from the dazzling brightneſs; whether he uſes any kind of perſpective-glaſs or not. I have known ſeveral perſons who have greatly injured and impair'd their eyes by looking on the Sun when eclipſed. A proper defence is ſo eaſily had, that no one need be without it. A piece of common clear window glaſs, drawn a few times thro' the flame of a candle or lamp, till it be covered with ſmoke, will effectually anſwer the purpoſe; and it may be cover'd thicker

thicker at one end than at the other, ſo as to be juſt ſuited to the degree of the Sun's brightneſs at any time. To prevent the ſmoke being rubb'd off, when in uſe, it will be beſt to have two ſuch pieces of glaſs, with their ſmoked ſides turn'd inward, and tied together, with a thread between them. Thus guarded, a perſon may view the Sun, without the leaſt danger to his eyes. But to ſee Venus, moſt people will ſtand in need of a perſpective.——A very agreable way of viewing the Tranſit, ſpots on the Sun, &c. is to tranſmit the Sun's rays thro' a teleſcope or perſpective, and receive them on a piece of white paper, held a few inches from the end of the teleſcope, and ſhaded from all other light. A perſon that deſires to obſerve the Tranſit, for uſe as well as entertainment, ſhould be furniſhed with a very good Teleſcope, and Clock, exactly adjuſted to the true time by altitudes of the Sun taken with an aſtronomical Quadrant or Tranſit-Inſtrument for ſeveral days; a common meridian line not being ſufficient in this caſe. He ſhould be free from every thing that may diſturb or take-off his attention; and therefore, in profound ſilence, and without any company but one or two aſſiſtants to watch the clock, and write the obſervations.

According to the lateſt corrections of Dr. Halley's Tables, We expect that in this place the phaſes will happen, as follows,

Venus

Venus will first touch the Sun's limb June 3, - -	2h	25′	36″
She will be totally within		44	8
The middle, or Venus nearest the Sun's centre -	5	36	8
The Planet being then 10′ to the North of it.			
True time of Sunset	7	29	48

The first impression of Venus will be made in a point about 11 degrees of the circumference of the Sun, to the right hand of the highest point of the Sun. And there it will appear in reflecting telescopes, and in the common sort of perspectives. But in astronomical refracting telescopes; which invert objects, it will appear as far to the left hand of the Sun's lowest point.

We heartily wish all curious Observers a serene sky.